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Exoskeleton Device Innovation Shows Potential for the Healthcare Industry

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Despite the exceptional performances we saw during the Beijing Olympics, the average human body is limited in how fast it can run, how high it can leap and how much weight it can carry. However, innovative technologies are emerging in the design of wearable robotic systems, or exoskeletons that might soon stretch those limits.

Originally designed for military applications, exoskeleton innovations are slowly blossoming in robotic orthotic devices designed to assist in rehabilitation programs for stroke victims, paraplegics and the mobility disabled. Exoskeletons also have tremendous potential in assisting emergency responders, nursing home and home healthcare workers, as well as farmers and factory workers, by reducing incidences of back strain or injury.

Current research and development has emerged from the cooperative work of the University of California Berkley and Oak Ridge National Laboratories, led by Dr. John Main. Wearable exoskeleton systems and components are being developed to enhance the performance of upper and/or lower extremities. Flexible, wearable robotic "suits" have been developed for whole-body performance improvement. This type of suit may include force sensors so that the suit is capable of sensing the user's motions.

In a model the University of Utah is developing, the joints are powered by hydraulic systems at the hip, knee and ankle for the lower body systems. Upper body systems are being designed to increase the arms' strength and mobility by enhancing performance at the shoulder, elbow and hand. Power source efficiency and minimal size and weight are critical elements in these exoskeleton systems' designs.

Rehabilitation Aid

Exoskeleton technologies are finding their way into the healthcare industry, too. Developed by Amit Goffer of Argo Medical Technologies in Israel, a new device called ReWalk enables paralyzed people to stand, walk and climb stairs independently. The ReWalk system is made of body sensors, leg supports, a computerized control box within a backpack and a remote control device contained within a wristband. When the user leans forward and picks a setting, the body sensors are activated, setting the robotic legs in action. Crutches are used to aid with balance.

About 700,000 people in the United States have a new or recurrent stroke each year. Of these, only about 10 percent will completely recover. The remainder will require rehabilitation. The combined direct and indirect costs of stroke were $62.7 billion in the United States in 2007, and rehabilitation accounts for $12.6 billion. The ReWalk is poised to enter the market in 2010 at a cost of about $20,000.

Reducing Back Injuries

In addition to providing rehabilitation, this technology can be used to prevent back injuries among both healthcare workers, first responders and others who frequently lift heavy objects in their work. According to OSHA, six of the top 10 professions with the highest risk

of back injuries are nurse's aides, licensed practical nurses, registered nurses, health aides, radiology technicians, and physical therapists. More than one third of back injuries are among nurses and attributed to the frequency with which they must handle and lift patients.

Back injuries have a worldwide prevalence of 17 percent. The annual prevalence is about 40-50 percent and lifetime prevalence of 35-80 percent. These staggering statistics provide a great potential market for the exoskeleton technology.

Challenges in Manufacturing

Actuation, power supply, weight and size considerations pose the greatest challenges in designing exoskeletons. Cumbersome, heavy systems are an obvious detriment, especially in the case of the paralyzed or physically weak user. Currently, exoskeleton systems developers are investigating improved materials to help minimize the weight and size of the components. The Defense Advanced Research Projects Agency (DARPA) is looking at composite materials that are lightweight, flexible and strong. Power to run the exoskeleton is generated by a wearable pack that needs to be lightweight and compact, yet contain enough power to last 24 hours.

The biomechanics of the exoskeleton introduces additional challenges. Whether for upper, lower body or full body use, it needs to be able to imitate natural human movement as closely as possible. Actuation and biomechanics need to be designed so that the movement is smooth from start to finish and changes in motion, like from walking to running or changing direction is not awkward.

The Future

Despite these challenges, further technological development and refinement is needed, especially within the healthcare industry. Although the technology is being actively developed for the military, some intellectual property filings reveal that medical applications are being addressed.

Wearable robotics systems have the potential to lower rehabilitation costs by allowing patients to stay in their homes. The ability to lift a patient or perform a rescue operation by using the human exoskeleton can greatly reduce the incidence of back injuries among healthcare professionals and first responders. This could reduce costs associated with worker's compensation, missed days, and work-related disability. With the economic burden associated with back injuries soaring in the healthcare industry, more research and development should be directed at the practicality of wearable robotics in the healthcare industry.